1	The electrical energy situation of French islands and
2	focus on the Corsican situation
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### 12 Abstract

13 The present work aims to present the electrical energy situation of several French islands spread 14 over the World. Various aspects are successively studied: repartition of energy means, renewable 15 energy part in the production with a focus on the intermittent renewable sources, legal and financial 16 aspect... The electrical situation of the islands is compared with the French mainland one. The 17 electricity production cost in the islands are presented and the financial features for renewable 18 energy in France are exposed. In a second part, a focus is realized on the Corsica Island situated in 19 the Mediterranean Sea and partially connected to Italy. Successively, the energy mix, the objective 20 of the new energy plan for 2023 and the renewable energy situation, present and future, are 21 presented. Even if the integration of non-programmable renewable energy plants is more complex 22 in small insular networks, the high cost of electricity generation in such territories encourages the 23 introduction of wind and PV systems. The islands are good laboratories for the development of 24 intermittent and stochastic renewable energy systems.

#### 25 Keywords

- 26 French islands, Corsica, Energy mix, Intermittent renewable energy, Insular context
- 27

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#### 28 1. INTRODUCTION

In Europe, there are about 300 islands (6% of the territory) for 14 M-inhabitants, i.e. higher than the population of some European countries. More than 100.000 islands of all sizes are scattered in the World in all the latitudes and longitudes with almost 500 M-inhabitants. The total islands area is 1/6 of the Earth area. In the second paragraph, the main French islands spread in all latitudes and longitudes and located in various seas are briefly presented.

An insular electrical system is governed by the same physical rules that a mainland network but the absence or the limitation of an interconnection to a large network grant some specificities recognized by the competent European and French authorities [1]. The electric particularities of islands are shown in paragraph 3.

In the fourth paragraph, the electrical energy mix of the main French islands is presented. It highlights that fuel generators are mainly used, inducing electricity production costs much higher than in mainland; which has led each state to adopt specific measures to take into account this specificity. The legal and financial measures taken for the French islands are presented in paragraph 5.

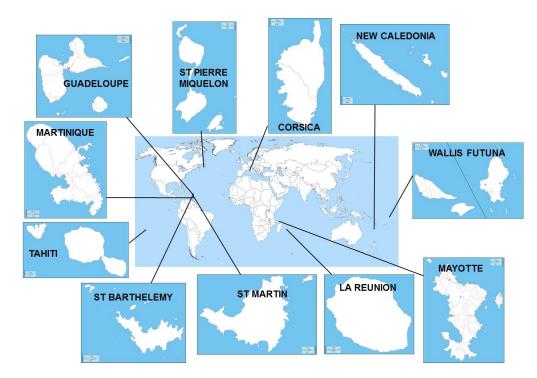
43 Despite the various conditions of consumption, of economic development, of renewable energy
44 potential and of cultural habits, numerous similarities exist from an electrical energy point of view
45 in all the islands in the World.

Even if the intermittent and stochastic character of the production raises more complex problems for islands than for large interconnected electrical networks, it will be shown that the part of these renewable energies in islands is higher than in mainland. It is due to the high cost of the other energy means which pushes islands to use their natural resources; this objective can only be reached with the development of efficient forecasting tools of the intermittent wind and PV energy production, through the development of energy storage means and with an optimal management of the energy flux via the utilization of smart grids.

At last, a special focus is realized on the energy situation of Corsica which has the specificity to be partially connected with the Italian mainland and the energy future of this island is presented. Its electrical energy situation is based on an energy tripod: 1/3 importation, 1/3 fuel and 1/3 renewable sources within the future a larger part for renewable energy and a reduction of the energy consumption.

## 58 2. THE MAIN FRENCH ISLANDS

The metropolitan France has about 1300 islands and islets mainly situated in Bretagne and in Mediterranean Sea. Corsica represents about 90% of the island area in the Metropolitan France. But the French territory spreads also from subarctic and Antarctic area to tropical and equatorial forests over the two hemispheres. The overseas territories are organized administratively in departments and communities, only the main (biggest) French islands are presented in Figure 1. Table 1 gives some information on surface, population and density.



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Figure 1. Main French islands presented in this study.

The sample of islands is very diversified by their geographical and meteorological situation, by their size from 21 km<sup>2</sup> for Saint Martin to 18576 km<sup>2</sup> for New Caledonia and by their population from 6000 inhabitants for St Pierre & Miquelon to more than 800 000 for La Reunion.

	Population	Surface	Density	Sea	
	(inhabitants)	(km <sup>2</sup> )	(inhabitants/km <sup>2</sup> )		
Corsica	337 796	8 680	39	Mediterranean	
Guadeloupe	390 704	1 628	240	Atlantic	
Martinique	371 246	1 128	329	Atlantic	
La Reunion	842 767	2 512	335	Indian ocean	
St Barthelemy	9 417	21	448	Atlantic	
St Martin	37 630	53	710	Atlantic	
St Pierre & Miquelon	6 312	242	26	Atlantic	
French Polynesia (Tahiti)	275 918	3 792	73	Pacific	
Mayotte	259 154	375	691	Indian ocean	
New Caledonia	268 767	18 576	14	Pacific	
Wallis & Futuna	11 901	142	84	Pacific	
France	67 186 638	551 695	122		

71 Table 1. Surface, population and density (2015) for the main French islands

#### 72 **3. SPECIFIC ENERGY PROBLEMS IN ISLANDS**

The islands being not or only partially interconnected with the mainland electrical network, the 73 74 energy manager has to reach the supply/demand balance without the assistance of external 75 production means located on neighbouring areas. Islands have a structural fragility: a short circuit in 76 the electrical system will generate a voltage drop in all the island [2-3], the low inertia implies a 77 high frequency variability with consequences on the voltage [2-3]; the previous problems are 78 compounded by the high unit size of an electrical generator in comparison with the peak power in 79 the network. The fault probabilities in an insular network are very high compared with an 80 interconnected network [3]. Voltage and frequency drops are more numerous and deeper in islands 81 than in mainland [2]. In Corsica, before the partial AC interconnection with Sardinia (Italy), more 82 than 200 failures per year occurred on the transmission network with voltage and frequency dips 83 (less than 46 Hz) [4].

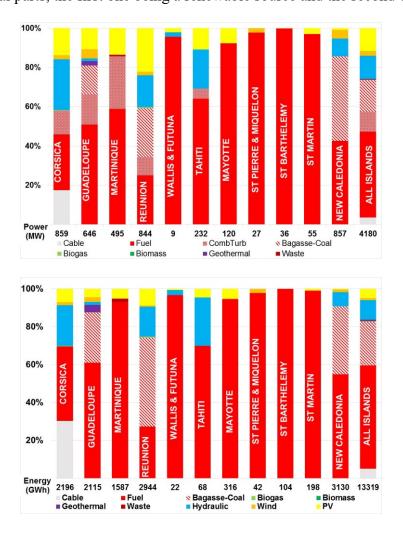
Islands have often a small population (see Table 1) and a variable energy consumption with a high gap between the minimum and maximum power (in Corsica, a minimum of 130 MW in May and a maximum of 500 MW in December); thus, high rated power production means are prohibited and only small electrical plants must be used for a better adaptation to the load and for limiting the disturbances due to the loss of an electrical plant. Thus, an electrical unit peak power must not exceed 25% of the average power in the network [1]. In the 300 GW European grid, the loss of a 1300 MW nuclear unit results in a ratio of 0.4%; in a 200 MW insular grid, the loss of a most powerful unit of 40 MW results in a ratio of 20% with obviously a difference of consequences: the loss of a 1300 MW nuclear unit on the French territory leads to a speed of the frequency variation of only 6 mHz/s, but, in Corsica, the loss of the 50 MW DC/AC conversion unit causes a variation of 2.8 Hz/s [5] much more difficult to compensate.

95 A margin of power must be available to react rapidly to an increase of the consumption or to a 96 decrease of production by another plant, the production group must operate at part-load (starting a 97 new plant takes time); then, it runs unfortunately with a lower efficiency and therefore produces a 98 kWh at a higher cost [3]. Another problem is due to the over-specialisation of the economy that 99 forces to install often an over-sized energy capacity to cover a high seasonal demand. The economy 100 of some islands is often based on tourism, this implies that the consumption increases during 101 summer when some energy resources (like hydroelectricity) are low or not available. Moreover, in this period, the drinkable water demand is high, making it more delicate to manage. In an island 102 103 grid, the electricity generation is heavily dependent on diesel engines, expensive and polluting but 104 appropriate according to their small unit size [6] and their relative starting-speed.

In view to ensure the security of electricity supply in a non-interconnected electrical network, a limitation to 30% of the intermittent renewable energies in the electrical network mix at each moment (French order of the 23 April 2008 [7]) has been introduced with obviously a negative impact on the PV and wind energy development in the islands. Beyond this limit, the electrical manager cannot ensure that the other electrical production means can compensate a sudden drop of intermittent production.

### 111 4. ELECTRICAL ENERGY SITUATION IN FRENCH ISLANDS

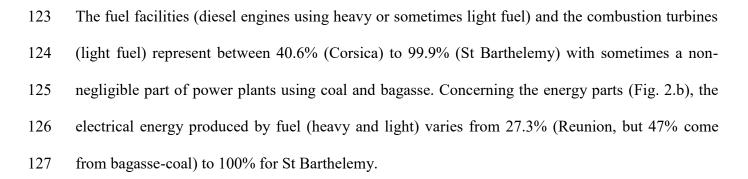
As previously underlined, diesel engines are the most adapted electricity sources for the islands due to their small nominal power and relative high ramp rate. The high contribution of fuel in the French islands is presented in Figure 2 for 2016 [8-12]. In Figure 2.a, we summed peak powers of fossil generators (guaranteed power) and of intermittent renewable systems (stochastic power). This presentation is misleading and should be discussed. The bagasse is a pulp remaining after the extraction of juice from sugar cane and is used as fuel. It was impossible to find the respective bagasse and the coal parts, the first one being a renewable source and the second one a fossil source.



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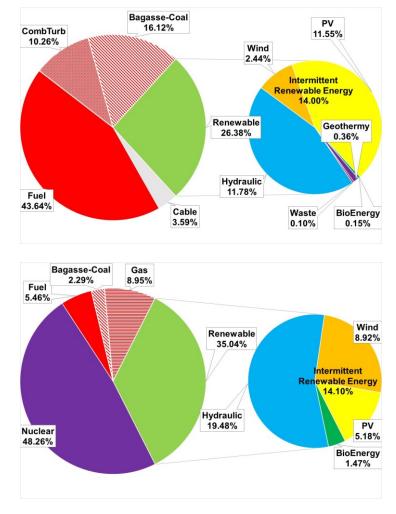
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Figure 2. Installed power (top) and produced energy (bottom) repartition in the French islands for
2016 [8-12]



The particularity of islands which imposes the utilization of fuel plant is even more visible when the electrical energy repartition is compared with the metropolitan French situation. Figure 3 shows the distribution of installed powers and of produced electrical energy for the French islands and for the

131 French mainland. We see that these distributions of the energy means differs widely [13].

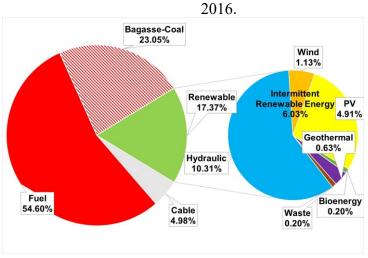


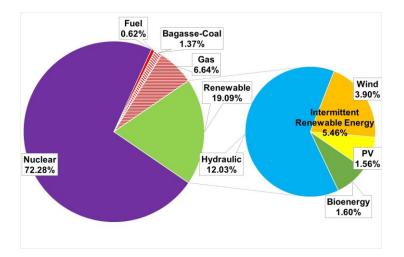
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a) Repartition in installed peak power for the French islands (top) and France (bottom) in





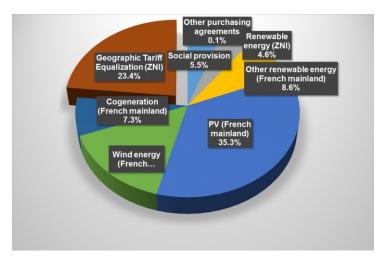
138 b) Repartition of produced energy for the French islands (top) and France (bottom) in 2016. 139 Figure 3. Comparison of the electrical energy situation for the French island and for France 140 The share of renewable energy in the total production is about 17.37% in 2016 against 19.09% for 141 the French mainland but the part of the intermittent renewable sources is higher in the islands. 142 France has a high hydraulic potential that it is rarely present in the islands. Moreover, the part of PV 143 energy is more important than wind energy in islands (80% PV/20% Wind) while the reverse is true 144 in France (30% PV/70% Wind), probably due to the difficulty to install large wind turbines in small 145 territories for technical, environmental and visual reasons. The electrical situation is very particular 146 in France because more than 72% of the electricity is produced by nuclear power plants.

## 147 5. LEGISLATIF AND FINANCIAL ASPECT

The European Union defined a special status for the "small isolated networks" for which the states members can adopt specific measures different from the European continent [14]. The French law [15] identifies some "area no-interconnected to the continental network" called ZNI (Zones Non Interconnectées): the French Overseas Communities and Departments must produce in totality their electricity (not interconnected) and largely in Corsica (partially connected).

The French laws impose [15-17] an equalization of electricity tariff over all the French Territory and took in place the Contribution to the Public Service of Electricity (CSPE in French) which is paid by all the consumers and serves particularly to compensate the high gap in insular area between the production cost and the regulated selling price of electricity. Moreover, a purchasing obligation for renewable power has been implemented by the law of February 2000 [15] and EDF, the French energy producer, is obliged to conclude some electricity purchasing agreements if independent producers request it. In the islands, EDF (or other electrical companies, electricity of Tahiti in Tahiti, ENERCAL and EEC in New Caledonia and EEWF Suez in Wallis and Futuna) ensures the public service i.e. production, single buyer, transport, distribution and marketing. The CSPE contributes also to compensate the over cost due to this purchasing obligation particularly for PV and wind energy.

Until 2010, the geographical tariff equalization generated the highest part in the CSPE. From 2011, the "renewable energy part" took the first place (60% in 2013) mainly due to the development of PV and to a lesser extent of wind energy. For 2015, the total amount for the CSPE was 6.3 billion  $\in$ with 1.3 billion  $\in$  for the tariff equalization in the non-interconnected areas [18-19]. The CSPE in 2015 represented 19.5  $\in$ /MWh (+3  $\in$ /MWh compared with 2014), its repartition and its evolution since 2003 are shown in Figure 4.



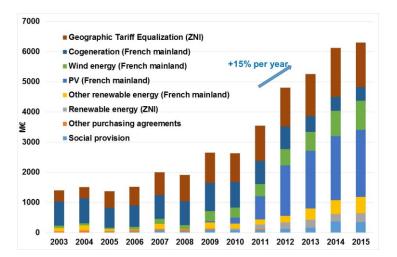
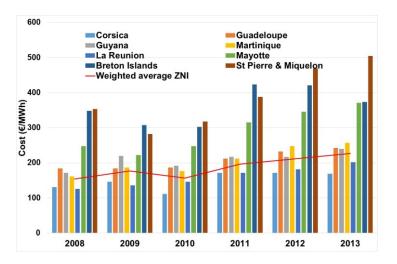


Figure 4. Repartition of the CSPE amount in 2015 for a total of 6.3 billion € and its annual
evolution [19].

According to the French Energy Regulation Commission (CRE), in 2010, the produced MWh cost was between 122 and 315  $\in$  for a regulated selling price at 51.7  $\notin$ /MWh [20]. In 2013, the electrical MWh cost price is around 225  $\notin$ /MWh i.e. between 4.5 and 5 times more expensive. The average cost per island depends on the characteristics of the production system. In 2013, it was 206  $\notin$ /MWh in La Reunion, 172  $\notin$ /MWh in Corsica, 259  $\notin$ /MWh in Martinique, 243  $\notin$ /MWh in Guyana and 247  $\notin$ /MWh in Guadeloupe [21]. The evolution of the cost price for ZNI and the average cost per island are shown in Figure 5 [21].

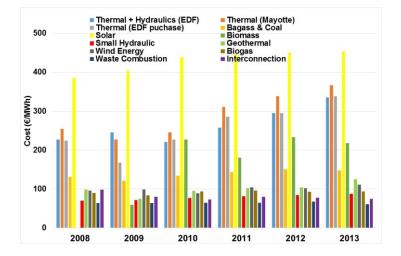
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Figure 5. Weighted average cost in ZNI and for each island from 2008 to 2013 [21].

For these costs, the following hypothesis were taken: its depends on the frequency of utilization of the combustion turbine (used for peak shaving and producing a kWh at a high price) and on the runoff, the increase of the electricity demand, exceptional events such as strikes, technical unavailability, ... The average cost for the French islands by energy production mean is shown in Figure 6.



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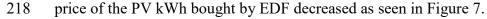
Figure 6. Production costs by production means [21]

191 It is unfortunately impossible to find production costs distinguishing combustion turbine (very 192 costly and using light fuel) and thermal motor (using heavy or light fuels).

193 The PV production is the most expensive with 450 €/MWh in 2013, the electricity production by 194 fuel follows. The production cost by bagasse and coal is relatively constant on the period 2008-2013 195 (between 120 and 150 €/MWh). The waste combustion, small hydraulic, geothermal energy and 196 wind energy are the most competitive but their development is relatively limited.

197 The high cost for the PV production is a consequence of the high purchase price introduced until 198 2010. Actually, the cost presented here is not the production cost but the purchase cost by EDF of 199 the PV kWh produced by a private company or an individual citizen. In view to boost the 200 development of the PV systems in France, and particularly in the islands (before 2005 with a special 201 price for Corsica and overseas departments), high purchase costs were imposed by the French 202 government. 203 Since it is not possible to obtain the production cost of the PV plant installed in the French island, 204 an order of magnitude of the production cost of a PV kWh by a utility was taken in IRENA report [22]: the 5<sup>th</sup> and 95<sup>th</sup> percentile range of the utility-scale LCOE declined from between 0.60 and 205 206 0.18 \$/kWh in 2010 (0.53-0.16 €/kWh) and between 0.31 and 0.07 \$/kWh in 2017 (0.27-0.06 207 €/kWh). In France, the average LCOE varied from 2010 to 2017 in average from 0.38 to 0.10 208 \$/kWh (0.33-0.09 €/kWh). It is difficult to make a comparison because the average cost of the PV 209 kWh presented in Figure 6 is calculated on the basis of PV plant installed over a period of many 210 years.

The feed-in tariffs for renewable electricity are applied on a contractual period given for each renewable energy [23]. The principles of purchase obligation are fixed by the law n° 2000-108 of the February 10, 2000 [15]. Some regular calls of tender are launched and some private agreements are signed on the basis of the methodology written by the Energy Regulatory Commission (CRE). Figure 7 shows the evolution of this price in France between 2002 and 2017; in 2010, due to the "too rapid" development of the PV systems in the French territory (due to a high purchase cost), a moratorium on the PV installation was decided by the French government; after this moratorium the



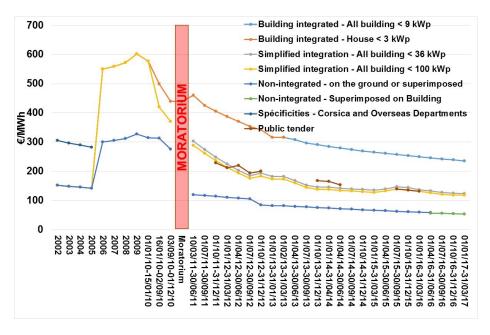




Figure 7. Evolution of the purchase cost (by EDF) of the PV kWh produced [24].

#### **6. CORSICAN ENERGY SITUATION**

### 222 6.1 Brief presentation of Corsica Island

With its 8680 km<sup>2</sup> and an average altitude of 568 meters, Corsica is the smallest, but the most mountainous of the three big occidental Mediterranean islands (Figure 8). The island is 183 km long from  $41^{\circ}19$ ' to  $43^{\circ}$  north, and 83.5 km large from  $6^{\circ}31$ ' to  $7^{\circ}13$  east.



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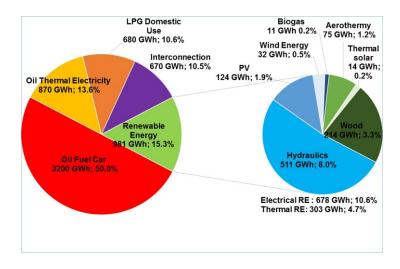
Figure 8. Position of the Corsica Island in the occidental Mediterranean Sea.

228 Mediterranean by its situation, Corsica is alpine by its structure. The central fold, of North-229 Northeast direction, South-Southeast direction which splits Corsica into 2 parts, forms a high barrier 230 which can be crossed over by passes often situated at a height of more than 1,000 m with snow in 231 winter. Corsica has 10 mountains exceeding 2,000 m (max 2,710 m) and more than 1,000 km of 232 coastal area. With about 337,796 inhabitants in 2015 (+1.2% per year), Corsica has an average 233 population density equal to 39 inhabitants/km<sup>2</sup>, the lowest of France (compared with 122 inhab/km<sup>2</sup> 234 in France). In rural areas, the density falls down to 7-10 inhab/km<sup>2</sup>. It is three times less populated than Balearics, six time less than Sardinia and twenty times less than Sicily. Two-thirds of the 235 236 population live in coastal areas and this is expected to rise up by three-quarters by 2030. During the 237 summer, the island has more than 1.3 million inhabitants (60% of the tourism is in July-August), 238 there are about 3 million tourists per year. This parameter is important for the energy production of 239 the island. Total employment is about 122,400 persons in 2015, the local economy is unbalanced:

- the tertiary sector represents 82.4% of jobs, industry 5.7%, agriculture 1.5% and construction 10.6
- 241 %. The GDP per capita (The Gross Domestic Product) is the lowest in France (26,432 € in 2014
- against 32,736 € for France i.e 19% inferior to the French average).

## 243 **6.2 Energy situation**

The insularity induces a high dependence for energy supply. Thus, even if the part of renewable energy in the energy mix is important, the island is dependent on exterior supply for about 87% of the total primary energy in 2014 (fuel for transport, for heating, for electrical production, high electrical importation from Italy and Sardinia, ...).



#### 248

Figure 9. Balance of final energy consumption in GWh (2014) (OREGES Corsica)

250 The balance for 2014 (Figure 9) without climatic correction in final energy is 6430 GWh (550

ktoe); the renewable energy in this balance represents about 16% of the final consumption.

In 2005, the Corsican Assembly (deliberative body of the Collectivity of Corsica) decided an energy plan for 2005-2025. The objectives were to obtain a tripartite repartition for the electricity production between:

- Renewable energy (mainly hydroelectricity 27%), PV (6%) and wind energy;
- Thermal production units;
- Electricity importation from Italy (SACOI cable) and Sardinia (SARCO cable).

The electrical system for Corsica in the end of 2016 is shown in Figure 10; Corsica is partially connected to the Italian mainland by two cables a DC one (SACOI 50 MW) and an AC one

- 260 (SARCO: 100 MW). Islands are rarely connected to mainland that makes Corsica particularly
- 261 interesting from en electrical point of view.
- 262 New production means have been realized during the last years:
- The investments were multiplied by 2 for the electrical network in view to improve the quality
  of the electricity;
- The power of the SARCO cable put into service in 2006 reached 100 MW in 2010;
- A new 40 MW combustion turbine (light fuel for peak shaving) in 2008;
- A new 55 MW hydraulic plant in Rizzanese in 2013.
- A new thermal power plant (Lucciana B) using light fuel in 2014.
- 269 The evolution of the electrical system in Corsica is shown in Table 2.
- In 2016, the renewable energies is 30.5% of the distributed electrical energy. The total energy produced in 2016 is 2196 GWh, the maximum power was 461 MW. The electricity demand in Corsica is very sensitive to climatic variations: about 37% of the consumption depends on the climate (temperature, nebulosity ...) for heating (24%) and cooling (13%). The electrical losses,
- difference between produced energy and distributed energy was equal to 270 GWh, i.e. 12.3%.
- The Corsican consumption depends on the season. The consumption is higher in winter due to the electrical heating. In summer, the cooling and the increase of the population due to the tourism conduce slightly to a lower consumption. The consumption is minimal in autumn and spring. The
- load profile was plotted in Figure 11 for about two years.

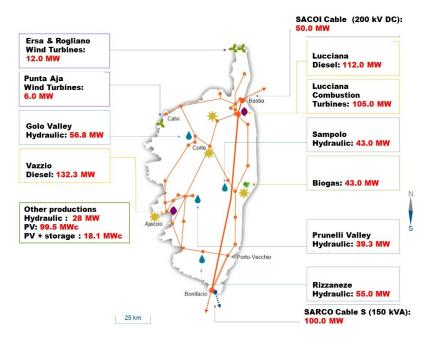
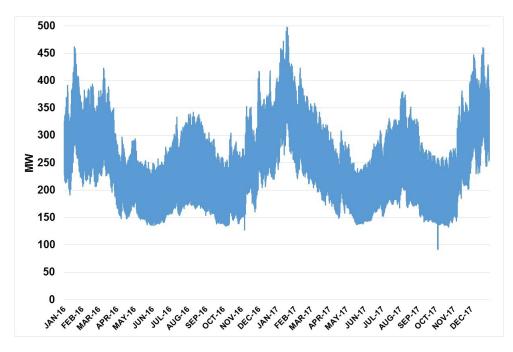
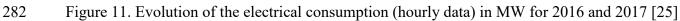


Figure 10. Electrical system in Corsica at the end of 2016 [8].







	2005				2015	
Туре	Site	Power	Total	Power	Total	
Thermal	Lucciana	77	209	112	244	
plant	Vazzio	132	209	132	(+35)	
Combustion	Lucciana	65	65	105	105	
turbine	Vazzio	0	05	0	(+40)	
Cables	SACOI	50	50	50	150	
	SARCO	0	50	100	(+100)	
Renewable	Hydro	139		194		
Energy	Small H	21		26		
	Wind	0	160	18	342	
	PV	0	100	97	(+182)	
	PV storage	0		5		
	Biogas	0		2		

285 Five typical electrical load profiles are plotted in Figure 12:

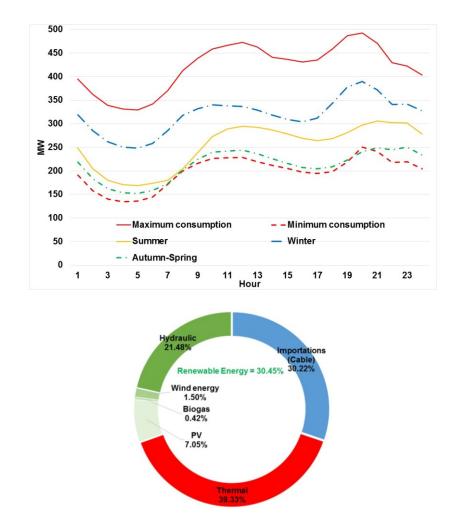
- The day with the maximum consumed power;

- The day with the minimum consumption (useful for estimating the disconnection of
 intermittent renewable energy systems due to the 30% limitation);

- One average day profile by season: winter, summer and Autumn-Spring.

The difference between the smaller and higher consumed power is important and the low consumption during some periods conduces to some disconnections of intermittent renewable energy plants.

The annual electrical energy mix in 2016 is presented in Figure 12. The repartition is about 1/3 for thermal energy (diesel), 1/3 for interconnection and 1/3 for renewable energy, it confirms the objective to have an energy tripod and progressively to increase the renewable energy part.



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Figure 12. The five typical load profiles for Corsica and the electrical mix in 2016 [25].

Figure 13 illustrates the energy means staking for a characteristic winter and summer day and for the day with the minimum consumption. The average MWh cost per hour was also plotted in Figure 13 [25]. It appears that during summer, the water resource is not used (generally, kept for drinkable water or agriculture utilization). The combustion turbines are used to shave the consumption electrical peak. The kWh cost varies greatly according to the repartition of the electrical production types, with a maximum when the costly combustion turbines are used and a minimum cost when hydraulic production is used (winter).

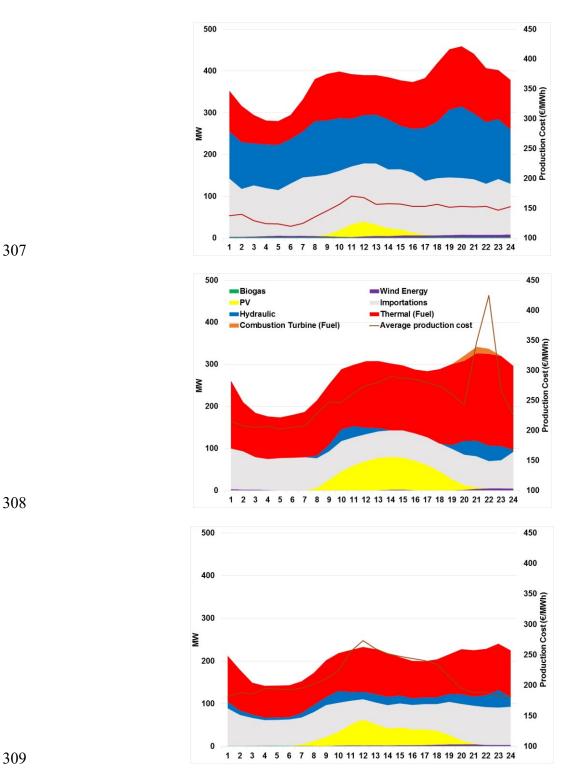
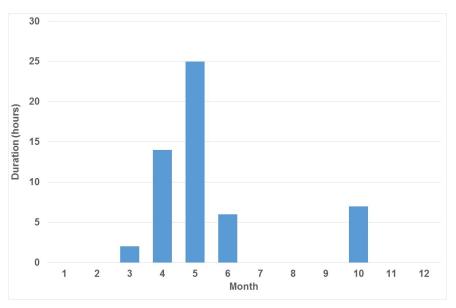


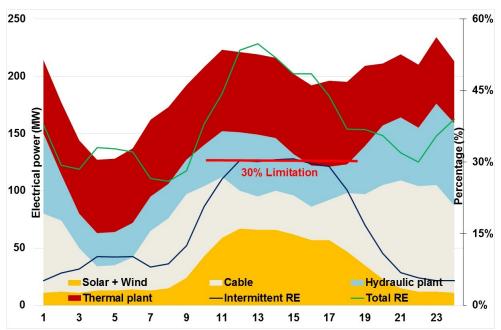
Figure 13. Energy means stacking for winter (18/01/2016), summer (09/08/2016) and for the day
with minimum consumption (11/06/2016 - minimum = 128 MW) [25]

Due to the small power consumption in some periods (mainly May and June, after the heating period and before the arrival of tourists) and the 30% limitation of the intermittent power on the grid, some disconnections of PV systems occur. Figure 14 shows an example of PV disconnection (23/05) when the 30% limit was reached and the monthly number of disconnections in 2016 for a 19 total number of 54 hours and a loss of PV energy produced equal to 577 MWh i.e. 0.4% of the total

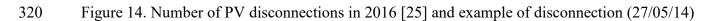


317 PV production in 2016.

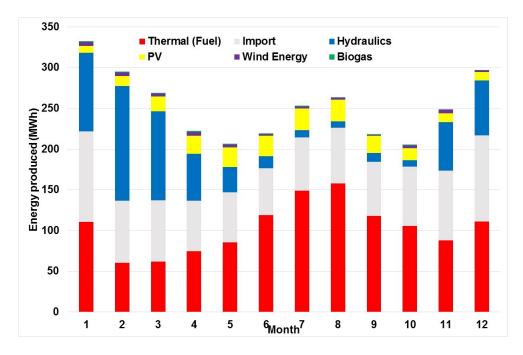




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321 The monthly energy mix is presented in Figure 15 for 2016.



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Figure 15. Electrical monthly energy in Corsica [25]

In winter, the thermal production is directly linked to the runoff and the temperature. The variability can be high from year to year. For the evening peak consumption in summer, hydraulic power plants being not available, all diesel engines being started on, a combustion turbine must be turned on. The security of the Corsican electrical grid must prevent a loss of an energy mean due to an unpredictable event. Thus, a failure with the SARCO cable will imply a disconnection of the wind and photovoltaic plants and of the DC/AC conversion station for the SACOI cable, it is a chain reaction.

The security can be guaranteed and efficient only if the sum of electrical powers injected on the network at each moment by renewable plants and by the two cables does not exceed a given limit of the total instantaneous load; this rule explains the variations of the imported power for the winter day. During summer, the hydraulic production is limited (decrease of the water potential and utilization of the dams for drinking water) and the diesel production is maximum. The production cost in Corsica from 2008 to 2013 is presented in Figure 16 [26].

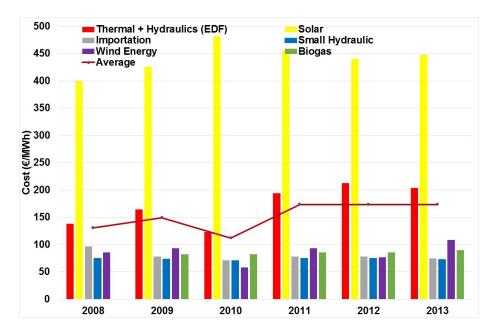




Figure 16. Production and purchase cost between 2008 and 2013 [26]

340 The small hydraulic plants produce electricity with the lower cost, followed by importation, biogas and wind energy. The data obtained by the Energy Regulation Commission do not allow 341 342 unfortunately to distinguish the costs for hydraulic and thermal plants. The high cost for PV 343 production (450€/kWh) is a consequence of the high purchase price introduced until 2010 (see 344 paragraph 5). The energy bought via the two cables SACOI and SARCO is very competitive and allows for Corsica to have a competitive price compared with the other ZNI (Figure 5). The 345 installed wind energy peak power has not increased since 2000 with 18 MW, but the total installed 346 347 PV peak power has increased very rapidly and reaches more than 140 MW today.

## 348 6.3 Expected future for Corsica

The long-term energy plan called PPE (Pluriannual Planning for Energy) is a management tool for the energy policy created by the decree n°2015-992 on the energy transition for the green growth [27]. It concerns the French metropolis and the non-interconnected area (ZNI). The PPE for the French metropolis is elaborated by the French government and for the ZNI are co-elaborated with the local authorities. This PPE covers two periods: 2016-2018/2019-2023. For Corsica, the PPE decree was published on 2015, 18 December [26], the main part of the information given in this paragraph comes from this decree. The main objectives are:

356	1. for electrical production:
357	• to increase the installed power of the renewable energy in the electrical production;
358	• to increase the production of heat and cold by renewable energy by 130 GWh in 2023
359	(compared to 2015).
360	2. for increasing the supply security:
361	• to increase the disconnection threshold for intermittent Renewable energy from 30% to 35%
362	in 2018 and 45% in 2023 particularly in developing energy storage for intermittent
363	renewable sources and in improving the reliability of the forecasting for PV and wind
364	production;
365	• to realize a gas supply infrastructure to supply the thermal electrical plants;
366	• to implement a new 250 MW combined cycle power plant using domestic fuel oil (until the
367	gas supply);
368	• to convert the thermal energy means in gas ones;
369	• to renew the DC cable and to increase its power to 100 MW.
370	3. for increasing the energy efficiency and decreasing the fossil fuel consumption:
371	• to develop 700 PV electrical charge ports for electrical vehicles:
372	• to reduce the energy consumption of 400 GWh until 2023.
373	4. concerning new infrastructures:
374	• to develop new hydraulic power plants
375	• to implement a hydro-pumping plant in an existing station.
376	7. Conclusion
377	The integration and development of renewable energy in the insular territories are in progress and
378	often reached a higher level than in French mainland. The higher cost of electricity production
379	pushes islands to use their natural resources in view to reach energy independence, to reduce their
380	fuel dependence and to preserve their environment.

381 The energy repartition between French islands and mainland was compared and important 382 differences were noted with considerable gaps from a cost point of view. Some legislative measures 383 were taken by the European Commission and the French government in view to reduce the price 384 gap for the electricity users.

385 Corsica presents some energy particularities such as a partial connection with Italy and an important 386 hydraulic potential rarely present in other islands. The main energy characteristics of Corsica were 387 given and the positive evolution of the energy mix was underlined.

388 The continuity of the renewable energy development will not be accomplished without the 389 development of efficient prediction of the intermittent energy production, without the development 390 of energy storage means and without an optimal management of the energy flux via the utilization 391 of smart grids. The islands are becoming renewable energy development laboratories and they 392 probably map the road for the future of the energy supply in the World.

A good example of such a positive evolution of the electrical supply towards the utilization of solar and wind sources, energy production and consumption forecasting and NaNiCl<sub>2</sub> energy storage via a smart-grid management is the H2020 project developed in the Greek island of Tilos [28]; such smart renewable energy systems can have an important development for small islands over the World.

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